

Olav Giere

BENTHOLOGY

MEIO



The Microscopic Fauna
in Aquatic Sediments

Springer-Verlag



Contents

1	Introduction	1
1.1	What is Meiofauna? Definitions	1
1.2	A History of Meiobenthology	2
2	Habitat, Habitat Conditions and Their Study Methods	5
2.1	Abiotic Habitat Factors (Sediment Physiography)	6
2.1.1	Structure of Sediment Pores and Particles	6
2.1.2	Granulometric Characteristics	7
2.1.2.1	Grain Size Composition	7
2.1.2.2	Exposure and Sediment Agitation	13
2.1.2.3	Permeability, Porosity and Pore Water Flow	14
2.1.2.4	Water Content and Water Saturation	15
2.1.3	Physico-Chemical Characteristics	17
2.1.3.1	Temperature	17
2.1.3.2	Salinity	18
2.1.3.3	pH Value	20
2.1.3.4	An Interacting Complex: Redox Potential, Oxygen and Hydrogen Sulphide	20
2.1.3.5	Pollutants	26
2.1.4	Conclusions	27
2.2	Biotic Habitat Factors	27
2.2.1	Dissolved Organic Matter (DOM)	28
2.2.2	Particulate Organic Matter	29
2.2.2.1	Mucus and Exopolymer Secretions	30
2.2.2.2	Detritus and Bacteria	31
2.2.3	Plants	35
2.2.4	Animals (Meio- and Macrofauna)	37
2.2.5	Animal Biogenic Structure (Tubes)	39
2.2.6	Conclusions	40
3	Meiofauna Sampling and Processing	44
3.1	Sampling	44
3.1.1	Number of Replicates, Sample Size	44
3.1.2	Sampling Devices	46

	Qualitative Sampling	46
3.1.2.1	Quantitative Sampling	47
3.1.2.2	Processing of Meiofauna Samples	54
3.2	Extraction of Meiofauna	54
3.2.1	Sample Staining	54
3.2.1.1	Qualitative Extraction	55
3.2.1.2	Quantitative Extraction	55
3.2.1.3	Fixation and Preservation	57
3.2.2	Selected Instruments for Processing of Meiofauna	
3.2.3	Organisms	59
3.3	Extraction of Pore Water	61
3.3.1	Suction Sampling	61
3.3.2	Squeeze Sampling	63
3.3.3	Centrifuge Sampling	63
4	Biological Characteristics of Meiofauna	64
4.1	Adaptations to the Biotope	64
4.1.1	Adaptations to Narrow Spaces: Miniaturization, Elongation, Flexibility	64
4.1.2	Adaptations to the Mobile Environment: Adhesion, Modes of Locomotion, Reinforcing Structures	68
4.1.3	Adaptations Related to the Three-Dimensional, Dark Environment: Static Organs, Reduction of Pigment and Eyes	74
4.1.4	Adaptations Related to Reproduction and Development	75
5	Meiofauna Taxa – a Systematic Account	78
5.1	Protista	78
5.1.1	Foraminifera (Sarcomastigophora, Rhizopoda)	78
5.1.2	Testacea (Rhizopoda)	80
5.1.3	Ciliophora	81
5.2	Cnidaria	85
5.2.1	Hydroida (Medusae)	86
5.2.2	Hydroida (Polyps)	88
5.2.3	Scyphozoa	88
5.2.4	Anthozoa	88
5.3	Free-Living Plathelminthes: Turbellarians	89
5.3.1	Acoela	91
5.3.2	Macrostomida	91
5.3.3	Rhabdocoela (= Neorhabdocoela)	91
5.3.4	Seriata	92
5.4	Gnathostomulida	96

5.5	Nemertinea	99
	Group of Nemathelminthes (= Aschelminthes)	101
5.6	Nematoda	102
5.7	Gastrotricha	110
5.8	Kinorhyncha	112
5.9	Priapulida	115
5.10	Loricifera	116
5.11	Rotifera, Rotatoria	118
5.12	Sipuncula	121
5.13	Mollusca	121
5.13.1	Gastropoda	123
5.13.2	Aplacophora	124
5.14	Annelida	124
5.14.1	Polychaeta	124
5.14.2	Oligochaeta	130
5.14.3	Annelida "incertae sedis"	134
5.15	Tardigrada	136
5.16	Crustacea	141
5.16.1	Cephalocarida (Anostraca)	142
5.16.2	Cladocera (Branchiopoda)	143
5.16.3	Ostracoda	144
5.16.4	Mystacocarida	147
5.16.5	Copepoda: Harpacticoida	149
5.16.6	Copepoda: Cyclopoida	154
5.16.7	Malacostraca	155
5.16.7.1	Syncarida	155
5.16.7.2	Thermosbaenacea, Pancarida	157
5.16.7.3	Peracarida	157
5.17	Acari	164
5.17.1	Halacaroidea: Halacaridae	164
5.17.2	Freshwater Mites: "Hydrachnellae", Stygothrombiidae and Others	167
5.18	Palpigradi (Arachnida)	168
5.19	Pycnogonida	168
5.20	Terrigenous Arthropoda (Thalassobionts)	169
5.21	Tentaculata	170
5.21.1	Brachiopoda	171
5.21.2	Bryozoa	172
5.22	Kamptozoa, Entoprocta	172
5.23	Echinodermata	172
5.23.1	Holothuroidea	174
5.24	Tunicata (Chordata)	174
5.24.1	Ascidiacea	175
5.24.2	Sorberacea	176
5.25	Meiofauna Taxa - Concluding Remarks	

6	Phylogenetic Aspects in Meiobenthology	177
6.1	Structural Considerations	177
6.2	Distributional Implications	181
7	The Distribution of Meiofauna	185
7.1	Mechanisms of Dispersal	185
7.1.1	The Plate Tectonics Theorem	185
7.1.2	Water Column Transportation	187
7.1.2.1	Erosion/Suspension	187
7.1.2.2	Emergence/Suspension	188
7.1.2.3	Rafting	190
7.1.2.4	Conclusions	191
7.2	General Distribution Patterns of Meiobenthos	192
7.2.1	Large-Scale Horizontal Distribution	193
7.2.2	A Typical Vertical Distribution Profile of Meiobenthos	194
8	Meiofauna in Selected Biotopes	197
8.1	Meiofauna in Brackish Waters	197
8.2	Meiofauna in Freshwater Biotopes	198
8.2.1	River Beds and River Shores	202
8.2.2	The Groundwater System	207
8.2.3	Stagnant Waters, Lakes	209
8.3	Meiofauna in the Deep-Sea	211
8.4	Meiofauna in Phytal Habitats	217
8.5	Meiofauna in Anoxic Environments – the Thiobios Problem	221
8.5.1	Historical Aspects	221
8.5.2	Composition of the Fauna	221
8.5.3	The Reduced Habitat and Its Impact on the Meiobenthos	224
8.5.4	The Food Spectrum of the Thiobios	227
8.5.5	Distributional Aspects	228
8.5.6	Aspects of Diversity and Evolution of Thiobios	230
8.6	Meiofauna in Polluted Areas	232
8.6.1	General Aspects	232
8.6.2	Methods for the Assessment of Pollution Using Meiofauna Data	235
8.6.3	Oil Pollution and Meiofauna – a Selected Case	242
8.6.4	Conclusions	245
9	Synecological Perspectives in Meiobenthology	247
9.1	Structural Aspects of Meiofauna Populations	247
9.1.1	The Size Spectrum	247

9.1.2	Factors Structuring Meiofauna Assemblages	249
9.2	Meiofauna Energetics: Abundance, Biomass and Production	252
9.2.1	General Considerations	252
9.2.2	Assessment of Energetic Parameters	254
9.2.2.1	Abundance, Density	254
9.2.2.2	Biomass	255
9.2.2.3	P/B-Ratio, Generation Time	257
9.2.2.4	Respiration	259
9.2.3	The Energetic Divergence Between Meiofauna and Macrofauna	261
9.3	The Position of Meiofauna in the Benthic Ecosystem	262
9.3.1	Links of Meiofauna to "the Small Food Web"	264
9.3.2	Links of Meiofauna to the Macrobenthos	266
9.3.3	Meiobenthos as an Integrative Benthic Complex	268
10	A Retrospect on Meiobenthology and an Outlook to Future Research	271
	References	275
	Glossary	321
	Subject Index	325